

Sour rot and Brown rot Management

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Sour rot on citrus background

Geotrichum citri-aurantii/ *Galactomyces citri-aurantii* (synonyms)

Water- and soilborne pathogen

- Transferred in citrus orchards via insects & soil splashes

Challenging to control without guazatine or propiconazole

- Banned from a lot of markets



Phytophthora brown rot on citrus

Citrus brown rot is caused by two *Phytophthora* spp.

- *P. citrophthora*
- *P. nicotianae* (more common in SA)

Occurs sporadically & severely

Phosphonates provide good pre-harvest control

Potassium phosphite dips = mostly effective

- Not used due to market restrictions on phosphorous acid residues

Other treatment options:

- FLU + AZO applied separately = great curative action on *P. nicotianae*



Sour rot & Brown rot similarities

Disease favors

- Mature, turgid fruit
- Rainfall/ high humidity during or right before harvest
- Low-hanging fruit (close to soil)

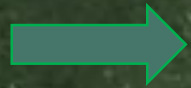
Decay can occur

- In orchard
- In shipping cartons (latent infections)
- Infects adjacent fruit

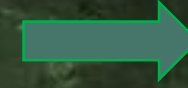


Management strategies

Pre-harvest



During harvest



Postharvest

Pre-harvest orchard sanitation

- Mechanical control
- Remove high risk fruit (fallen, decaying, damaged, low hanging & fruit from previous season)
- Practice tree skirting



Management strategies

During harvest

- Avoid harvesting early morning, during/ right after rainfall
- Fill bins only $\frac{1}{2}$ for soft citrus
- Full bins acceptable for oranges & lemons
- Do not snap-pick
- Sanitise pruning shears
- Train picking team on preventing fruit injuries
- Avoid picking/ touching high-risk fruit if left in orchard



Management strategies

Postharvest

- Treat fruit ASAP after harvest
- Cool fruit after boxing ASAP if possible (rarely in SA)
- Potassium sorbate (**PS**) and/or clove oil (**CL**) in the
 - EU CODEX MRL for potassium sorbate = 20 ppm
 - **Test samples for residue analysis**
- Pre-packhouse drench and/or fungicide bath
- **NB: Do prior phytotoxicity & residue tests**
- **High risk: Phytotoxicity, calyx desiccation**



M&M's: Sour rot synthetic & GRAS screening trials

Initial curative (18-20hr) screenings done for later refinement and pack-line strategy planning

GRAS chemicals + synthetics @ **0.75 X** & **0.5 X** registered dosage rate

Synthetics tested

- **IMZ** (Imazalil sulphate 750 SG)
- **TBZ** (Thiabendazole 500 SC)
- **AZO** (Azoxystrobin 250 SC)
- **FLU** (Fludioxonil 230 SC)
- **PYR** (Pyrimethanil 400 SC)
- **OPP** (Ortho-phenyl phenol 10%)

GRAS chemicals tested

- **PS** (Potassium sorbate)
- **PS+CL** (Potassium sorbate + clove oil)
- **CL** (Clove oil)
- Carbohydrate-derived fulvic acid
- Inorganic salts
- Plant extracts

M&M – Sour rot pack-line trials

Same protocol as screening trials

- 18-20 hr curative before 1st treatment

Extra steps added at various time points to simulate citrus pack-line system

- Pre-packhouse drench
 - 24-72 hr before pack-line
- Sanitiser bath
- Fungicide bath
- Wax application

All actives in this study are from products registered for postharvest use on citrus

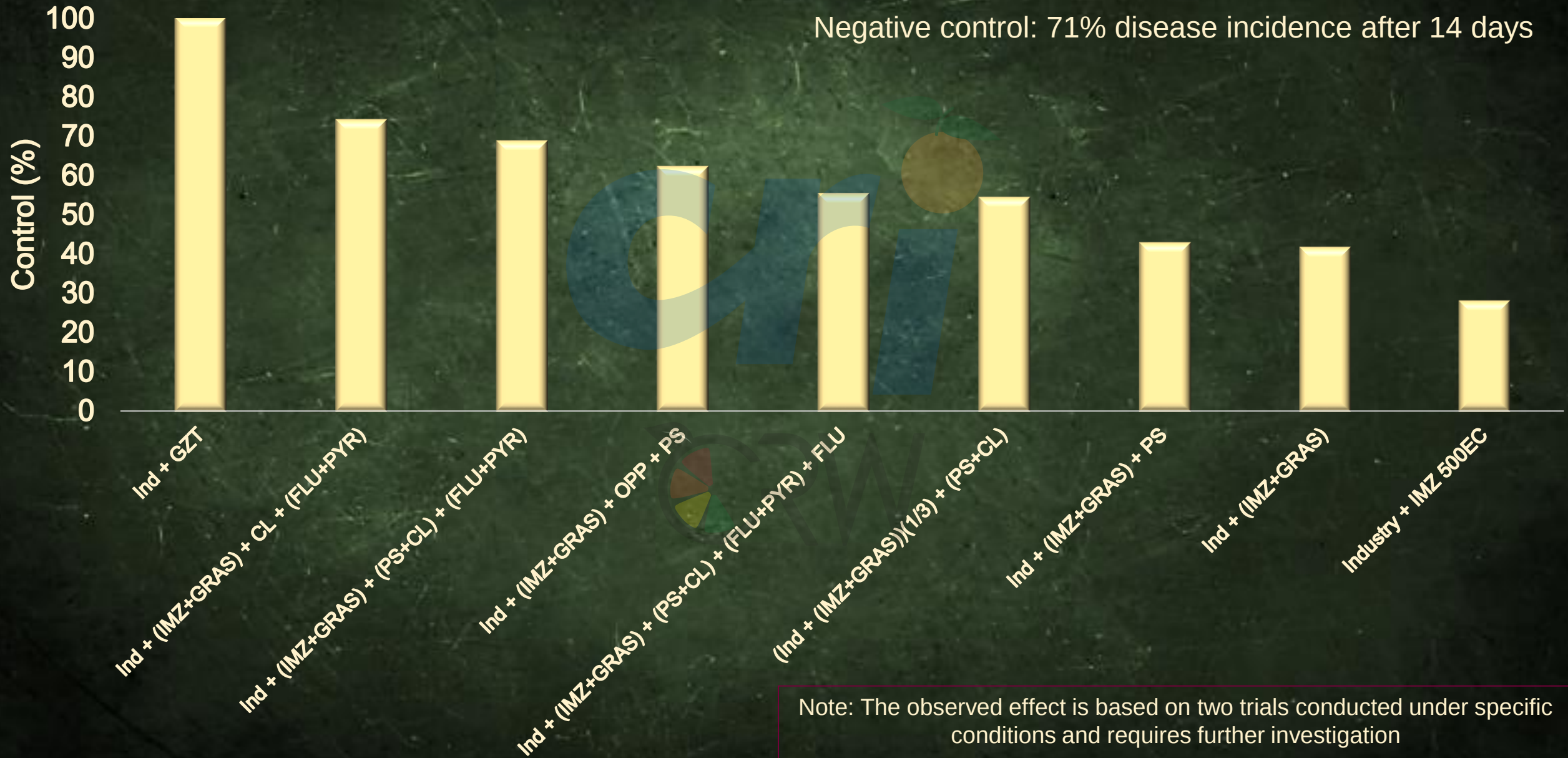


Concentrations of active ingredients and GRAS chemicals used in pack-line trials

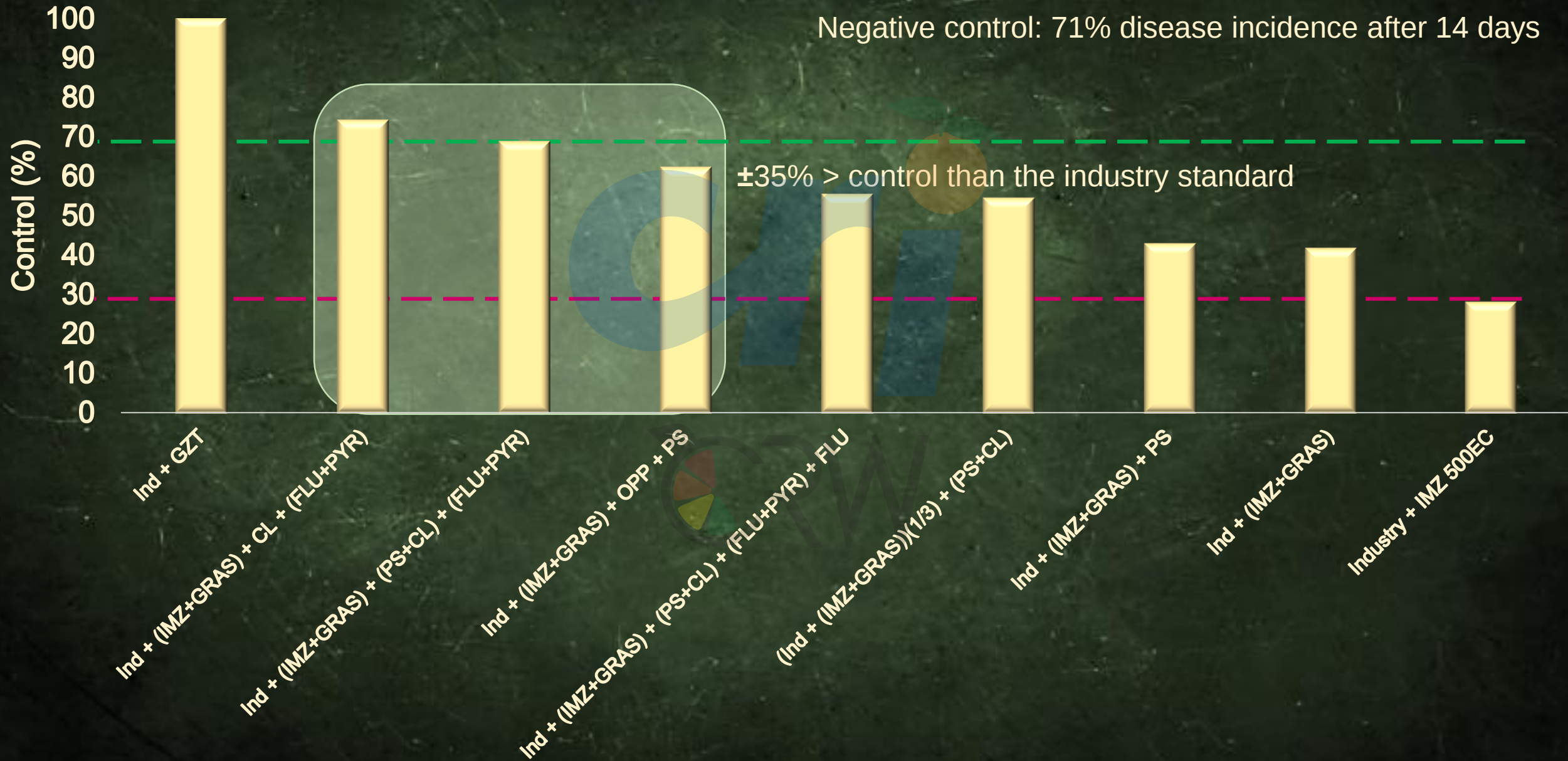
Active	Concentration (ppm)	Active	Concentration (ppm)
Pre-packhouse drench		Sanitation bath	
2,4-dichlorophenoxyacetic acid 25 SL (2,4-D)	250	Calcium hypochlorite (Ca(ClO)₂)	150
Clove oil (CL)	2000	Fungicide bath	
Didecyldimethylammonium chloride (DDAC)	1500	CL	2000
Fludioxonil 100 EC + Pyrimethanil 400 SC (FLU+PYR)	200 + 800	GZT	1000
Guazatine 210 SL (GZT)	1000	Imazalil-sulphate 750 SG (IMZ-S)	500
Ortho-phenyl phenol (OPP)	2000	OPP	2000
Peracetic acid + hydrogen peroxide (PAA)	150 + 230	PAA	150 + 230
Potassium sorbate (PS)	3000–7500*	PS	3000–7500*
Potassium sorbate + clove oil (PS+CL)	8000–11000* + 2000	PS+CL	8000–11000* + 2000
Pyrimethanil 400 SC (PYR)	1000	TBZ	1000
Thiabendazole 500 SC (TBZ)	1000	Wax treatment	
		2,4-D	250
		Imazalil 300 EC + GRAS (IMZ+GRAS)	3000 + 3000–6000*
		Imazalil 500 EC (IMZ)	2000
		OPP	2000
		TBZ	4000

*Concentration of active ingredient in product is given as a range

Curative packline treatments - sour rot on lemons (with pre-packhouse drench)



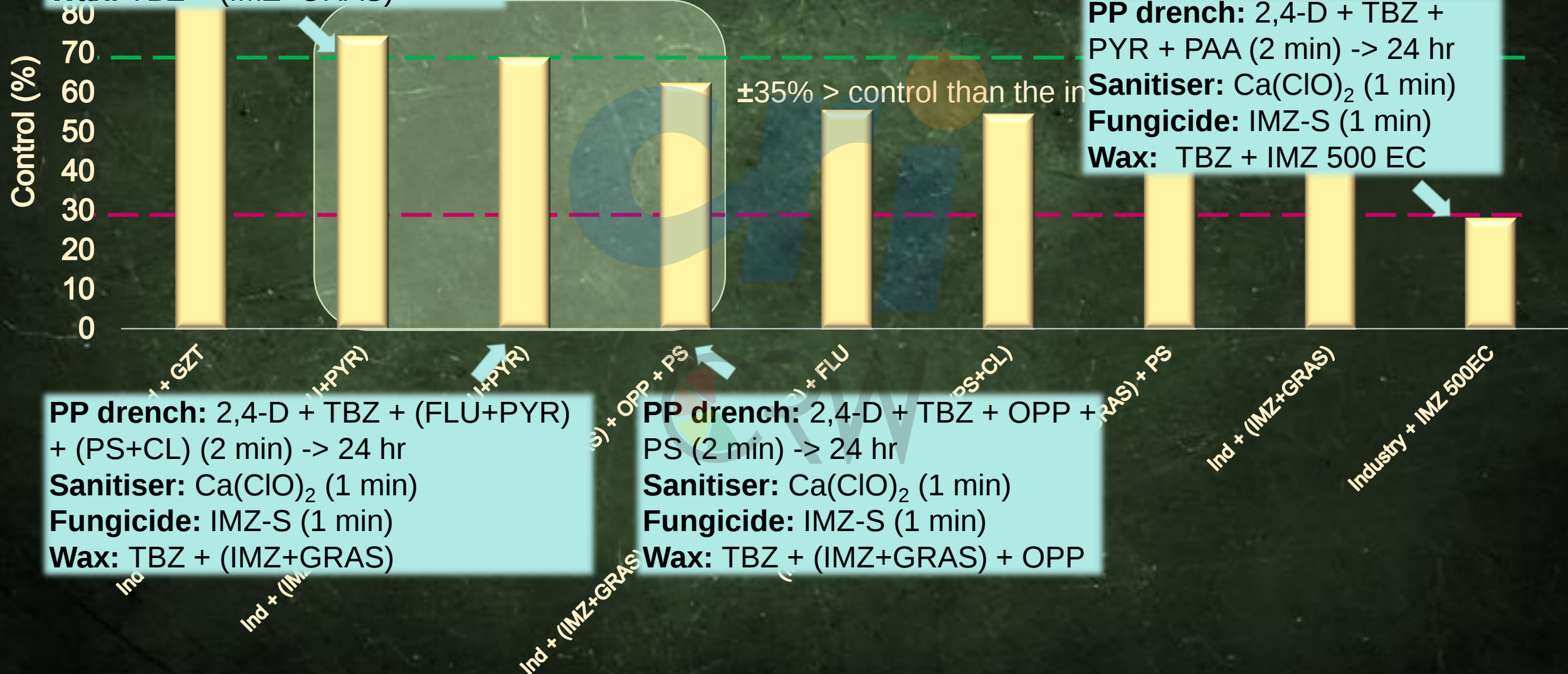
Curative packline treatments - sour rot on lemons (with pre-packhouse drench)



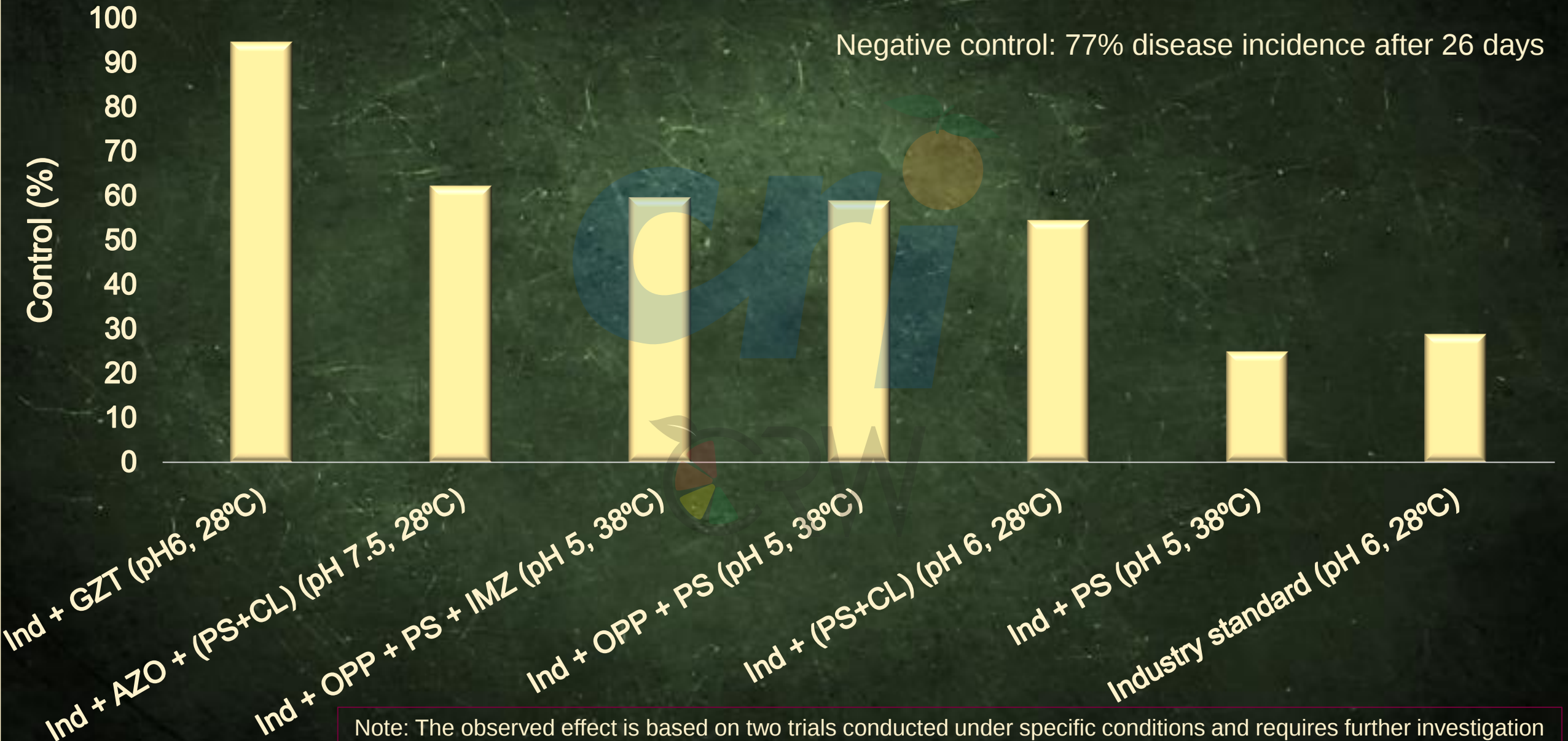
Curative packline treatments - sour rot on lemons (with pre-packhouse drench)

PP drench: 2,4-D + TBZ + (FLU+PYR) + CL (2min) -> 24 hr
Sanitiser: Ca(ClO)₂ (1 min)
Fungicide: IMZ-S (1 min)
Wax: TBZ + (IMZ+GRAS)

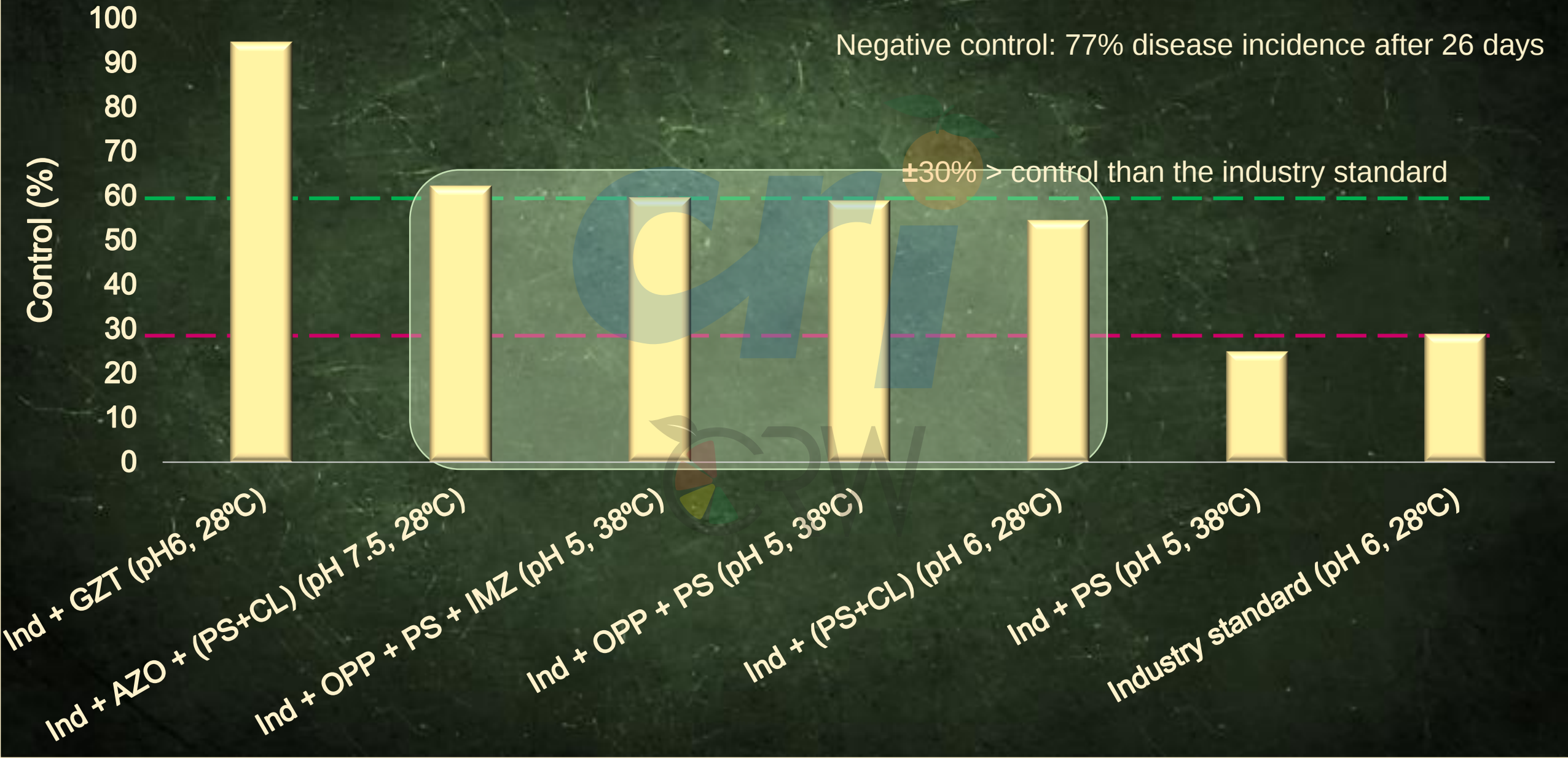
Negative control: 71% disease incidence after 14 days



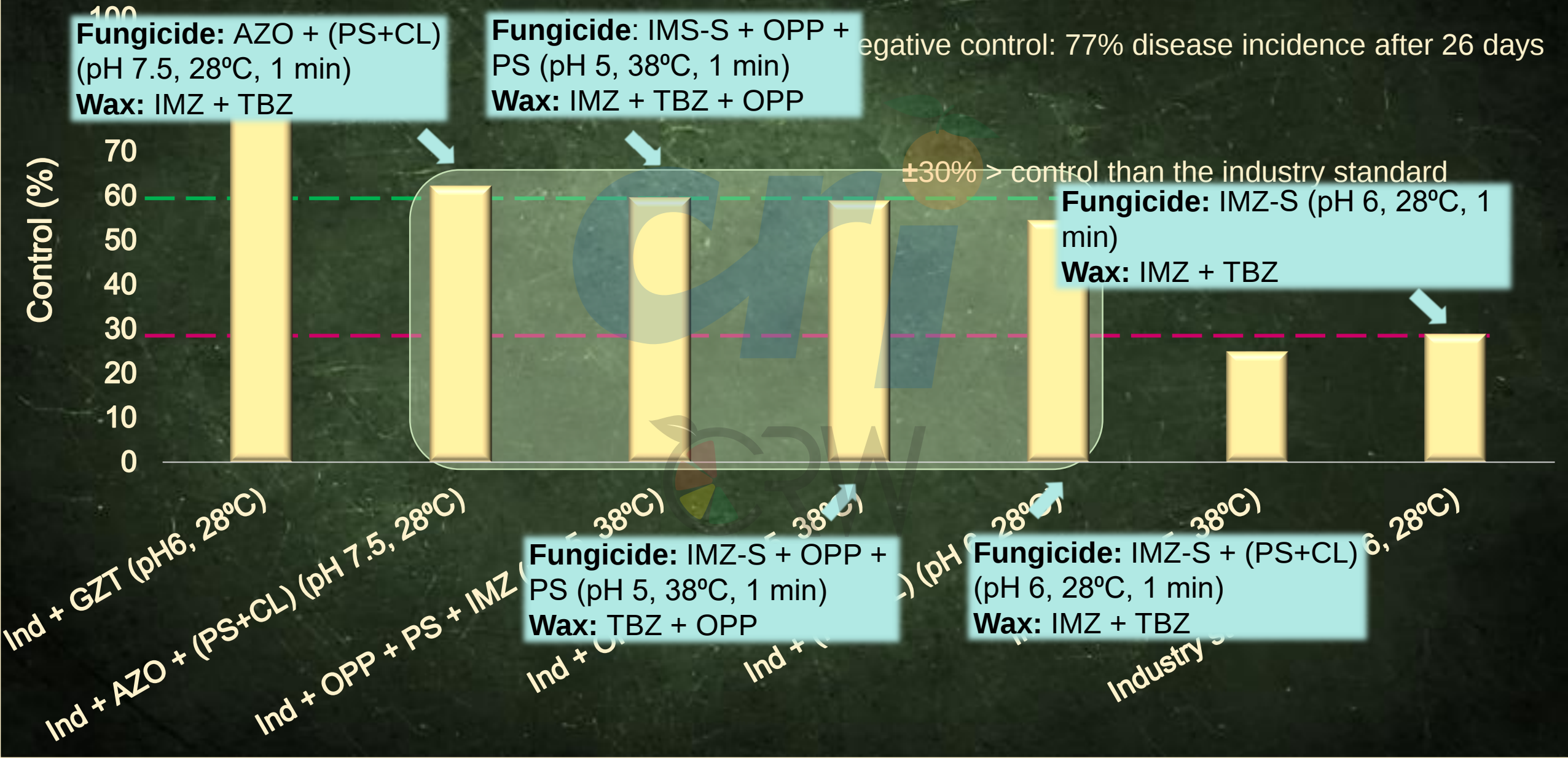
Curative packline treatments - sour rot on Valencias (no pre-packhouse drench, temperature-adjusted)



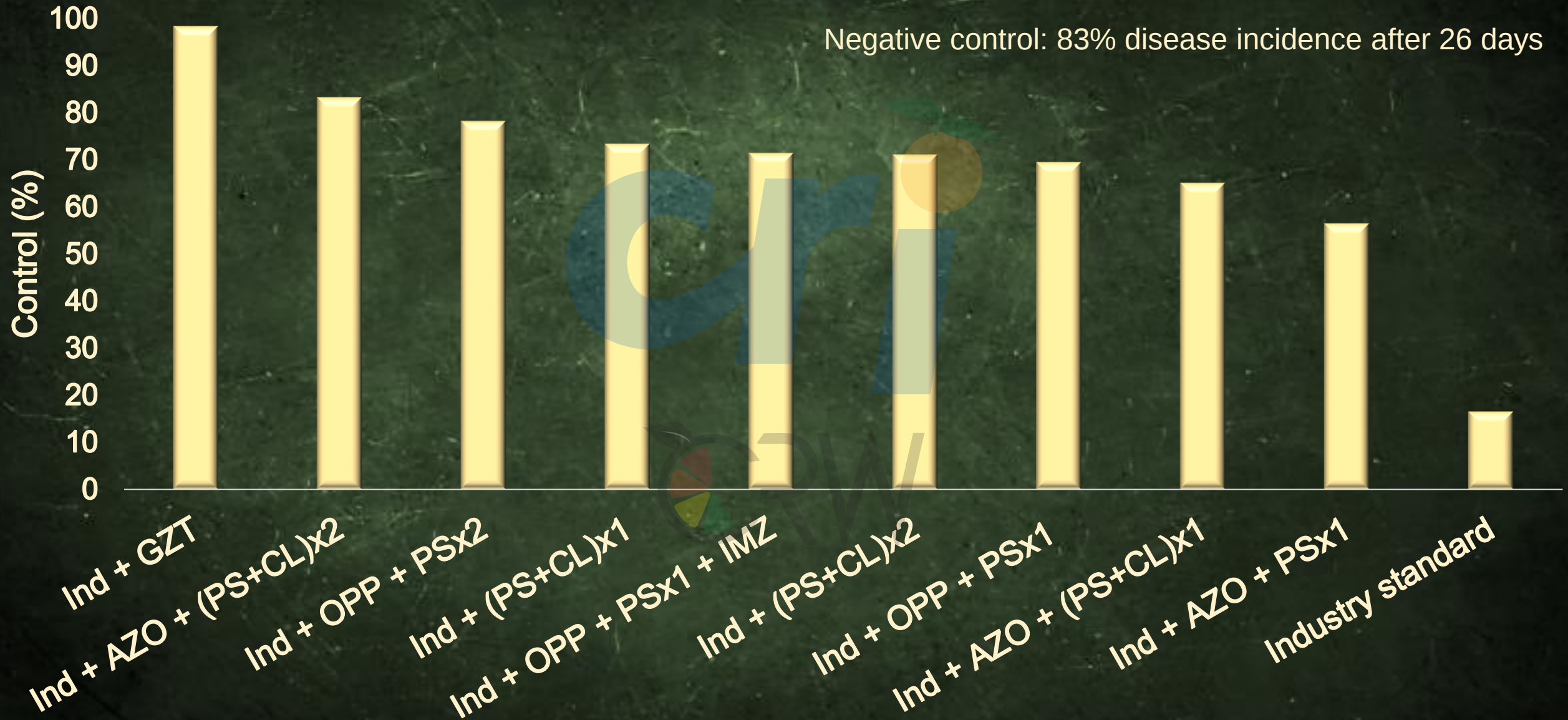
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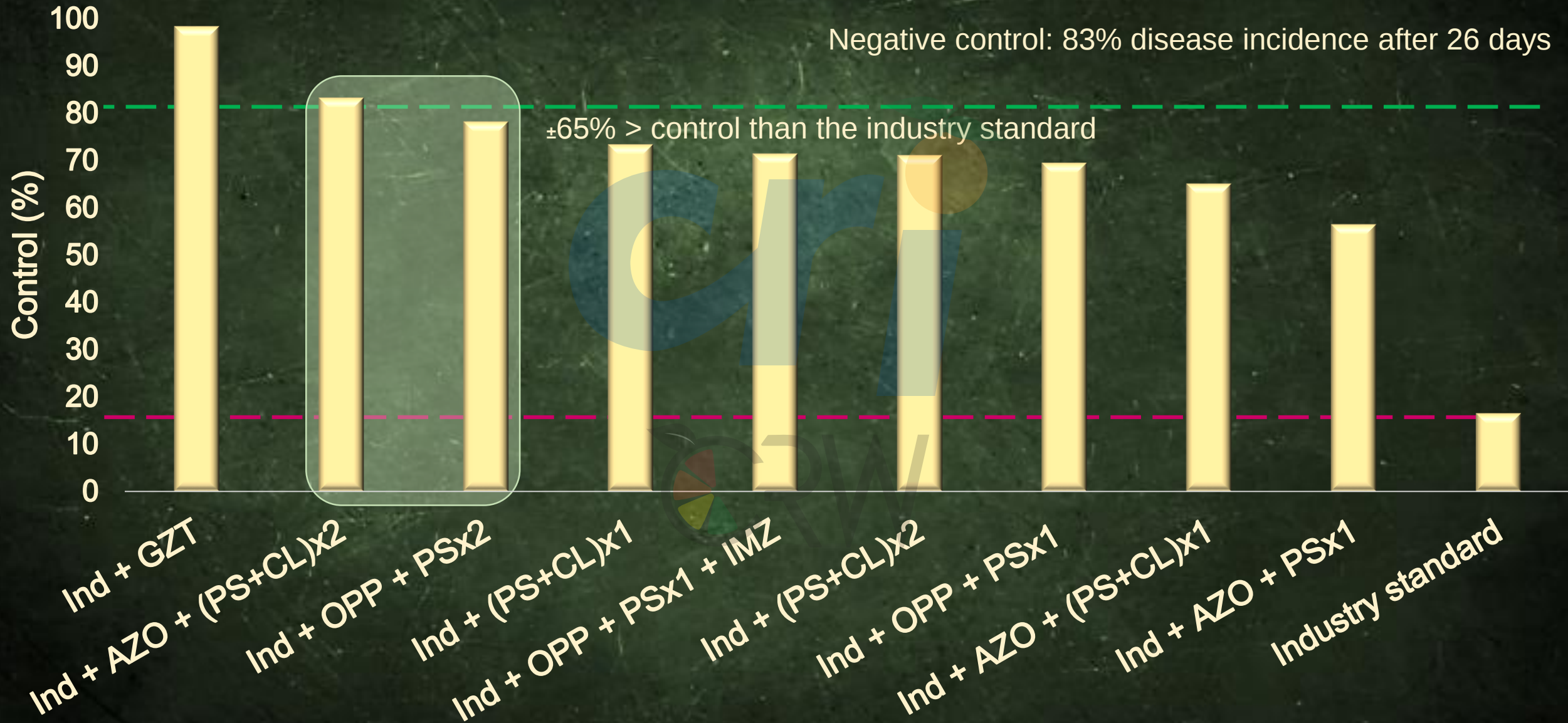


Curative packline treatments - sour rot on Valencias (with pre-packhouse drench, temperature-adjusted)

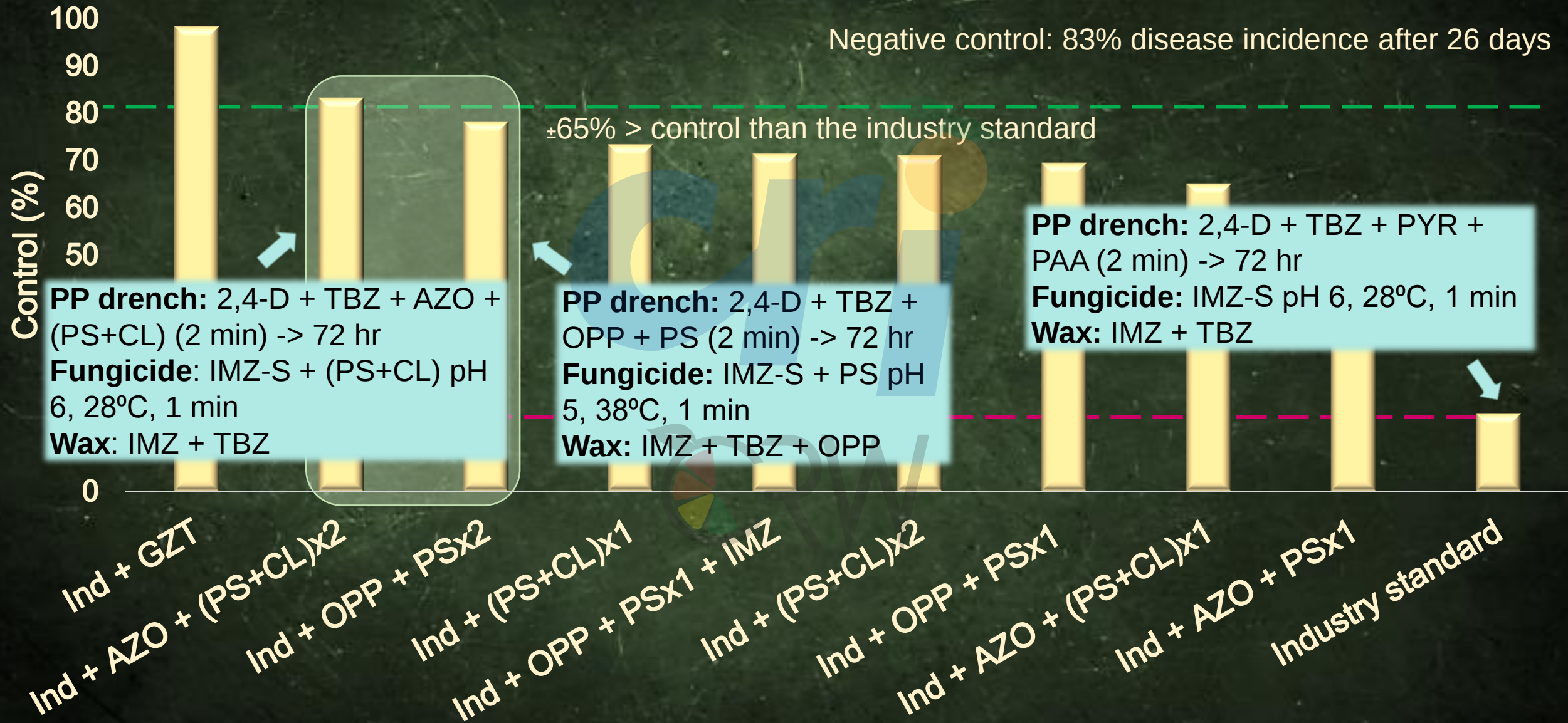


Note: The observed effect is based on two trials conducted under specific conditions and requires further investigation

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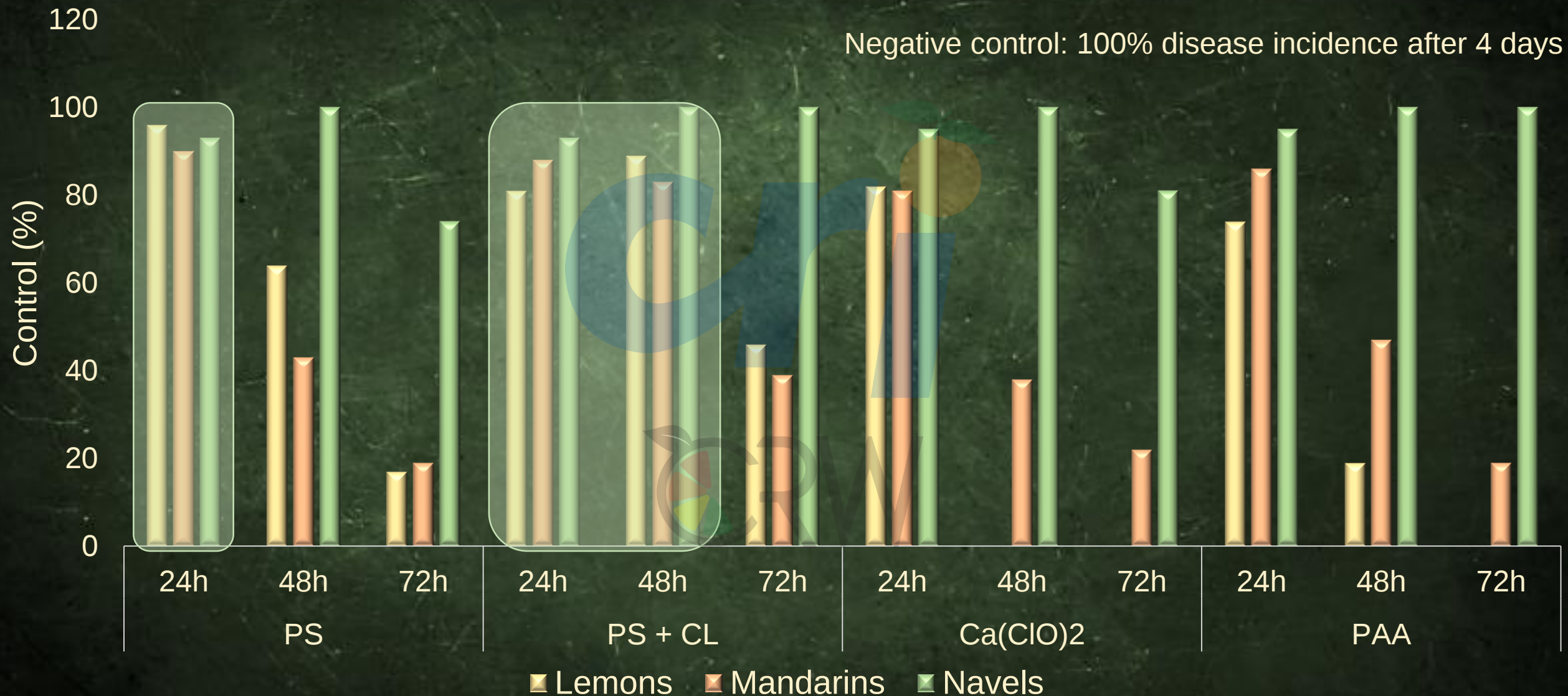


CRI Research – Brown rot

Brown rot M&M ->	Effect of sanitisers
Pathogen	3 x10 ⁵ zoospores/mL <i>Phytophthora nicotianae</i>
Wounding	220 grit sandpaper, twice on opposite sides of fruit equator
Inoculum	Soaked in 1cm ² miracloth, placed on wound, left to dry, removed
Infection time (Curative, before treatment)	29°C, dark, humid, 24, 48, & 72 hrs
Fruit type	Lemons, mandarins, navels
Treatment	Dipped for two minutes in sanitiser solutions
Incubation	29°C, dark, humid, 4 days before rating

Active	Concentration	Exposure time
Calcium hypochlorite	200 ppm (100 ppm active chlorine)	2 min
Potassium sorbate + clove oil	(8000–11000) + 2000 ppm	2 min
Peracetic acid	250 ppm	2 min
Potassium sorbate	2000–5000 ppm	2 min

Percentage curative control at different time-points of brown rot treated with sanitisers



Note: The observed effect is based on two trials conducted under specific conditions and requires further investigation

Sour- & brown rot postharvest recommendations

Current recommendation: Add only one PS and/or CL treatment in the postharvest treatment program

- Decreases chance of rind, stem-end and MRL issues
- **Test all cultivars for problems prior to use**

Pre-packhouse drench included = Best option

Pre-packhouse drench	Sanitiser	Fungicide	Wax
2,4-D + TBZ + AZO + CL	Ca(ClO) ₂ or PAA	IMZ-S	TBZ + IMZ
2,4-D + TBZ + AZO + (PS+CL)	Ca(ClO) ₂ or PAA	IMZ-S	TBZ + IMZ
2,4-D + TBZ + OPP + PS	Ca(ClO) ₂ or PAA	IMZ-S	TBZ + IMZ

Without pre-packhouse drench = 2nd best

Sanitiser	Fungicide	Wax
Ca(ClO) ₂ or PAA	IMZ-S + (PS+CL)	TBZ + IMZ
Ca(ClO) ₂ or PAA	AZO + (PS+CL)	TBZ + IMZ
Ca(ClO) ₂ or PAA	IMZ-S + OPP + PS	TBZ + IMZ

In Conclusion

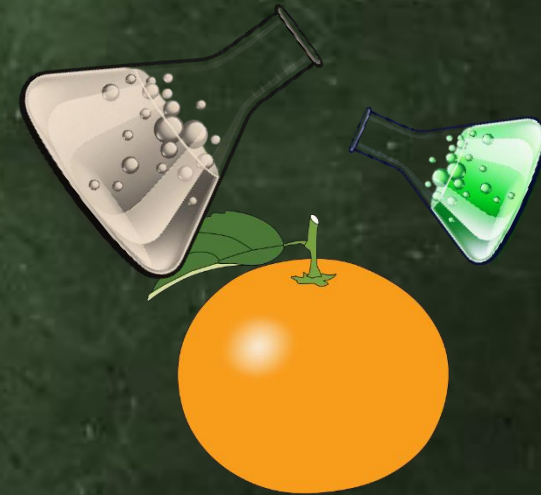
Research still ongoing

More residue & rind testing necessary regarding PS and CL

Room for possible other GRAS chemicals in the industry

Packhouses should assess

- Risk of disease pressure in area
- Market restrictions
- Cultivar sensitivity to phytotoxicity
- Residue-related risks



Acknowledgements

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Skhulile Gwebu
Jan Landman
Natasha Jackson
Rudolph Strydom

A wooden shelf with wooden blocks spelling 'THANK YOU'. The blocks are light-colored wood with dark letters. The word 'THANK' is on the left and 'YOU' is on the right. The shelf is made of a single piece of wood. In the background, there is a large, stylized, semi-transparent logo that appears to be 'CVC' in blue and green colors. The background is dark and textured, with some blurred green and yellow light sources on the right side.

THANK YOU